

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
1 May 2003 (01.05.2003)

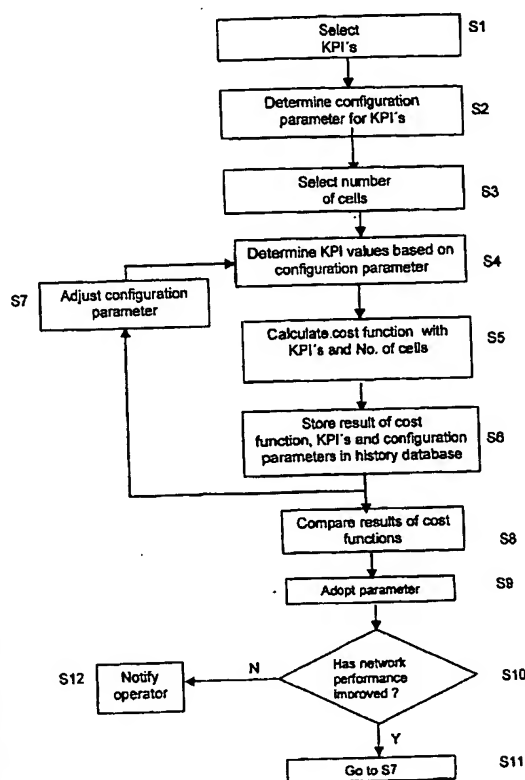
PCT

(10) International Publication Number  
**WO 03/037018 A1**

- (51) International Patent Classification<sup>7</sup>: **H04Q 7/36**, H04L 12/24
- (74) Agent: **UNGERER, Olaf**; Eisenführ, Speiser & Partner, Association No. 15, Arnulfstr. 25, 80335 München (DE).
- (21) International Application Number: **PCT/EP01/12374**
- (22) International Filing Date: **25 October 2001 (25.10.2001)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (71) Applicant (for all designated States except US): **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **LAIHO, Jaana** [FI/FI]; Paasitie 6 A, FIN-02880 Veikkola (FI). **HÖGLUND, Albert** [FI/FI]; Tammitie 18 A 11, FIN-00330 Helsinki (FI). **NOVOSAD, Tomas** [CZ/FI]; Tallberginkatu 3 A 8, FIN-00180 Helsinki (FI).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: **METHOD AND SYSTEM FOR OPTIMISING THE PERFORMANCE OF A NETWORK**



(57) Abstract: When optimising the performance of the network, first of all, the relevant key performance indicators for a specific entity within the network as well as first parameters, which influence the key performance indicators, are determined. A number of entities similar to said specific entity is selected, wherein relevant key performance indicators are associated to every entity. The key performance indicators as well as the selected number of entities are used as elements in a first cost function, i.e. said first cost function is calculated on the basis of the KPI and the number of entities. Said first cost function is calculated in order to evaluate the network performance. Accordingly, since said first parameters directly relate to the key performance indicators, the network performance will depend on the values of said first parameters. Thereafter the values of said first parameters are adjusted, so that a second set of values of said first parameters are obtained. The key performance indicators are determined again but this time on the basis of the second values of said first parameters and said first cost function is re-calculated on the basis of these key performance indicators. The result of said first cost function calculated on the basis of said first values of said first parameters is compared to the result of said first cost function re-calculated on the basis of said second values of said first parameters. This comparison is carried out to determine whether the network performance has improved. When the network performance has improved due to the adjusting of said first parameters, said second values of said first parameters are adopted as permanent parameters.

WO 03/037018 A1

WO 03/037018 A1



**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## **Method and system for optimising the performance of a network**

### **FIELD OF THE INVENTION**

5

The invention relates to a method and system for optimising the performance of a network.

### **BACKGROUND OF THE INVENTION**

10

Telecommunications Management Network (TMN) model provides a widely accepted view about how the business of a service provider is to be managed. The TMN model consists of four layers, usually arranged in a triangle or pyramid, with business management at the top, service management the second layer, network management the third layer, and element management at the bottom. Management decisions at each layer are different but related to each other. Working from the top down, each layer imposes requirements on the layer below. Working from the bottom up, each layer provides important source of data to the layer above. The

15

20 TeleManagement Forum's (TMF) TMN sets the guidelines for the optimisation functionalities and processes. The 3<sup>rd</sup> Generation Partnership Project (3GPP) has adopted the same model. The scope of TMF is to find standardised way to define service quality, set requirements for networks in terms of quality of service (QoS) measurements, and make it possible to

25 have QoS reports between providers and systems that implement the service.

According to the TMN model the information from the upper level systems flows down, guaranteeing seamless operation and optimisation possibilities for the network. The TMN model is depicted in Fig. 3. The information flow from the business management layers all the way down to the service management and network management layers is essential since the business aspects have to be considered carefully in the optimisation and network development process. The TMN model demonstrates the change of

30

- 2 -

the abstraction level in the operator's daily work. The business plan efficiency can be measured with capital and operational expenditure (CAPEX, OPEX) and revenue. The wanted business scenario is then translated to offered services, service priorities and service QoS requirements. On the  
5 lowest (network element) level of the TMN model the business related issues are converted into configuration parameter settings.

Functions supported by TMN's Business Management Systems are, for example, to create an investment plan, to define the main QoS criteria for  
10 the proposed network and its services, to create a technical development path (expansion plan) to ensure that the anticipated growth in subscriber numbers is provided for.

Functions supported by Service Management Systems are for example to  
15 take care of subscriber data, the provision of services and subscribers, to collect and rate bill offered services, to create, promote and monitor services.

Functions supported by Network Management Systems (NMS) are to plan  
20 the network, to collect information from the underlying networks and pre/post-process the raw data, to analyse and distribute information, to optimise network capacity and quality.

Element management systems can be considered as part of Network  
25 Element functionality with the responsibility to monitor the functioning of the equipment, to collect raw data (performance indicators), provide local graphical user interface (GUI) for site engineers, and to mediate towards the NMS system.

30 In addition to TMN, the TMF also defines a Telecom Operations Map (TOM). Telecom and data service providers must apply a customer ori-

- 3 -

ented service management approach using business process management methodologies to cost effectively manage their businesses and deliver the service and quality customers require. TOM identifies a number of operations management processes covering Customer Care, Service  
5 Management and Network Management. The Telecom Operations Map uses the layers of the TMN model as core business processes, but divides the service management layer into 2 parts: Customer Care and Service Development and Operations. Customer Interface Management is separately delineated, because Customer Interface Management may be managed within the individual Customer Care sub-process or, in combination  
10 across one or more of the Customer Care sub-processes.

Fig. 4 shows the high-level structure of Network Management processes and the supporting Function Set Groups. According to the framework provided by TOM it is possible to map each of the high level processes to a  
15 series of component functions (arranged in function set groups). Provided that:

- Network performance management (PM) provides adequate measurements;
- 20 • Network configuration management supports the whole TMF framework;
- There is intelligence in network management system (NMS) to combine these two information.

25 It then identifies relationships and information flows between them. In Fig. 4 the TOM and its components are presented. The functionalities of the layers are the same as in Fig. 3 to indicate the corresponding management layers.

30 A detailed description of the TMN model and the TOM can be found on the homepage of the TMF (see <http://www.tmforum.org>).

- 4 -

In current cellular systems the radio resources are handled with numerous parameters, wherein the parameter value settings are fixed even in changing conditions. The task of an operator is to manually tune the parameter settings to meet the right operating point in terms of quality of service. Often the objective when doing optimising has been "just to get it working". This tuning has been relatively straightforward in simple GSM networks with pure speech services. In the case of WCDMA the complexity of these parameter settings is manifold: multiple services, service classes, even multi-radio environment. The WCDMA based cellular systems will offer variability of packet and circuit switched services and therefore are more complicated to plan and control than today's networks. The strong coupling of the cells adds the complexity. For an operator it is essential to utilise all possible resources to improve the capacity and Quality of Service (QoS) of the radio network.

A network optimising process serves to improve the overall network quality as experienced by the mobile subscriber and to ensure an efficient use of the network resources. The optimising process includes the analysis of the network and improvements in the network configuration and performance. Statistics of key performance indicators (KPI) for the operational network are fed to a tool for analysing the network status and the radio resource management (RRM) parameters can be manually tuned for the better performance. The key performance indicators (KPI) are defined in an initial phase of the optimisation process. They consist for example of measurements in the network management system (NMS) and of field measurement data or any other information, which can be used to determine the quality of service (QoS) of the network. For a second generation systems quality of service QoS has consisted for example of dropped call statistics, dropped call cause analysis, handover statistics and measurements of successful call attempts, while for third generation systems with a greater

- 5 -

variety of services new definitions of quality of service QoS for quality analysis must be generated.

To optimise the overall revenue of a network operator or a service provider  
5 reducing the costs of the operation and maintenance of a network system  
has prompted the need for process automation in said network system.

### SUMMARY OF THE INVENTION

10 It is therefore an object of the invention to improve the process of optimising network resources.

This object is solved by a method for optimising the performance of a network according to claim 1, a corresponding system according to claim 12.

15

The invention is based on the idea to optimise network resources by means of one centralised cost function rather than optimising the network resources separately.

20 Currently the radio resource management algorithms are parameterised separately: handover control, admission control, power control etc. parameter values are set independently and one can identify cases where for example hand over problems are due to wrong power control (CPICH) setting. Change in the admission control setting can result in a change in the  
25 quality of the packet data.

Therefore, when optimising the performance of the network, first of all, the relevant key performance indicators for a specific entity within the network as well as first parameters, which influence the key performance indicators, are determined. A number of entities similar to said specific entity is  
30 selected, wherein relevant key performance indicators are associated to

- 6 -

every entity. The key performance indicators as well as the selected number of entities are used as elements in a first cost function, i.e. said first cost function is calculated on the basis of the KPI and the number of entities. Said first cost function is calculated in order to evaluate the network performance. Accordingly, since said first parameters directly relate to the key performance indicators, the network performance will be depend on first values of said first parameters.

Thereafter the values of said first parameters are adjusted, so that a second set of values of said first parameters are obtained. The key performance indicators are determined again but this time on the basis of the second values of said first parameters and said first cost function is recalculated on the basis of these key performance indicators. The result of said first cost function calculated on the basis of said first values of said first parameters is compared to the result of said first cost function recalculated on the basis of said second values of said first parameters. This comparison is carried out to determine whether the network performance has improved. When the network performance has improved due to the adjusting of said first parameters, said second values of said first parameters are adopted as permanent parameters.

Setting separate parameters based on many algorithms rather than optimising a parameter set with a central control function can cause oscillations in the parameter values, since cases may occur where changing one parameter to optimise a KPI may adversely affect other KPI's. Therefore, it is advantageous to monitor the radio resource management as a whole by a centralised cost function rather than individual functions, in order to coordinate the changing of the respective parameters.

According to a development of the invention, the respective key performance indicators are weighted with different weight coefficients within said



- 7 -

first cost function. Using different weight coefficients allows to allocate more influence of one or more key performance indicators on the first cost function.

- 5 According to a further development of the invention, reference values for the key performance indicators are set and the key performance indicators in the first cost function are replaced by the difference between the current key performance indicators and the respective reference values (to define the "cost" see equation (1)). Hence, the first cost function is now calculated on the basis of the difference between the current key performance indicators and the respective reference of values. This allows to set quality of service targets based on the cost of the KPI(s) on the system.
- 10

- According to a preferred development of the invention, said first cost function is composed of a second and a third cost function, wherein said second cost function represents the quality requirements within the network and said third cost function represents the capacity requirements within the network. Said second cost function is weighted with a second weight coefficient while said third cost function is weighted with a third weight coefficient. Providing the second and third cost function in connection with their respective weight coefficients makes it possible to incorporate the trade-off between capacity and quality within the first cost function.
- 15
- 20

- According to a further preferred development of the invention, the second and third cost function are composed of the selected entities, wherein the determined key performance indicators are associated to each entity. This allows to incorporate a broad distribution of key performance indicators from across the network.
- 25

- 30 According to a further development of the invention, said entity can be represented by the cell or the user group within the network. Accordingly, the

- 8 -

cost function can be calculated for example on the basis of a cell or a cluster of cells.

5 According to a further preferred development of the invention, the steps for optimising the network performance are iterated, so that the optimising process can be automated.

10 According to still a further preferred development of the invention, the values of the KPI's together with the respective first parameters and the corresponding result of the first cost function are stored to create a history database. The current result of said first cost function is compared with previous results thereof stored in the history database in order to determine whether the network performance has improved within a predetermined time interval. However, if no improvements of the network performance have been made within said predetermined time interval a respective  
15 notification is being issued. Issuing the notification when no improvements are detected for a predetermined time interval, can avoid the occurrence of deadlock during the automated process and point out to possible problems.

20

### BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the present invention will be described in greater detail on the basis of preferred embodiments with reference to the accompanying  
25 drawings, in which:

Fig. 1 shows a flow chart of an automated process for optimising the network performance

30 Fig. 2 shows an example of a KPI cost function;

- 9 -

Fig. 3 shows a diagram of the telecommunications management network (TMN) model;

Fig. 4 shows a diagram of the Telecom operation map (TOM), and

5

Fig. 5 shows an illustration of the combination of monitoring and optimising functions to combine different management layers.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

10

In Fig 1 a flow chart of an automated process for optimising the network performance according to the first embodiment is shown. First of all, in the step S1, those key performance indicators, which describe the performance of the part of interest of the network, are selected. Then, in step S2 those configuration parameters, upon which the KPI's depend on, are determined. In step S3 the number of cells, which are to be included into the optimising process, are selected, i.e. selecting a cluster of cells. The current values of the KPI's are determined based on the respective configuration parameters in step S4. Thereafter, in step S5 the cost function is calculated on the basis of the current values of the KPI's and the number of cells. The result of the cost function, the values of the KPI's and the configuration parameters are stored in a history database in step S6.

20

At least one value of the respective configuration parameters is adjusted in step S7, resulting in a new set of configuration parameters. Based on this new set of configuration parameters new KPI values are determined in step S4 and the cost function is re-calculated in step S5 on the basis of the new KPI values and the (unchanged) number of cells as selected in step S3. The new result of the cost function, the new KPI and configuration parameter values are also stored in the history database in step S6. Subsequently, the new result of the cost function - based on the

25

30

- 10 -

new/adjusted set of configuration parameters - is compared to previous results of the cost function stored in the history database in step S8 in order to determine whether the network performance of interest has improved after adjusting the configuration parameters.

5

If the network performance has improved after adjusting the configuration parameters, the adjusted set of configuration parameters are adopted as permanent parameters in step S9. While, if it has been determined in step S8 that the network performance has not improved after adjusting the configuration parameters, the first set of configuration parameters, as stored in the history database in step S6, are adopted as permanent parameters in step S9.

15 In step S10 is checked whether the network performance has improved within a predetermined time interval. When the network performance has not improved during the predetermined time interval, i.e. the KPI history has not improved even though auto-tuning is performed, the network operator is notified in step S12 that a problem has occurred with the automated process for optimising the network performance. Since it is clear  
20 that many of the parameter values will not be auto-tuned, and that auto-tuning cannot always optimise the network, the operator can then check whether this problem is due to hardware problems or whether - under the current network conditions - it is not possible to automatically optimise the network performance. In such a case of the network operator will have to  
25 resume to manually optimise the network performance.

On the other side when the network performance has improved during the predetermined time interval the flow jumps to step S7 where the configuration parameters are adjusted again in order to further optimise the network  
30 performance. The flow will then continue as described above.

- 11 -

In a second embodiment not only the relevant KPI's are selected in step S1 but also a set of QoS targets is determined, which is expressed in a set of reference KPI. The automated process for optimising the network performance according to the second embodiment corresponds substantially to the optimising process according to the first embodiment. The only difference is that the difference between the KPI and the reference KPI is used instead of the KPI value when the calculating the cost function in step S5.

- 10 Accordingly, the operator sets capacity requirements for certain capacity KPIs denoted KPI\_C with "ref" in the sub-index. Correspondingly, the operator sets quality requirements for certain KPI\_Qs. The quality and capacity costs can then be calculated as in equation (1).

$$\begin{aligned}
 \text{QualityCost} &= \sum_{\text{cells} \in \text{CLUSTER}} \sum_i \alpha_i * f(KPI\_Q_i - KPI\_Q_{i,ref}) \\
 15 \quad \text{CapacityCost} &= \sum_{\text{cells} \in \text{CLUSTER}} \sum_i \beta_i * f(KPI\_C_i - KPI\_C_{i,ref}) \quad (1)
 \end{aligned}$$

Different cost functions can be combined or summed with weight coefficients  $\alpha$  and  $\beta$ . By controlling or changing weight coefficients  $\alpha$  and  $\beta$  a certain type of cost can be emphasised and the overall some.

20

The mathematical formulation of the task of optimising the network performance can be seen as to find a combination of air interface configuration parameters based on which the KPIs are as close to the desired area as possible.

25

Fig. 2 shows an example of a KPI cost function  $f$ . In this example, the cost for KPI values higher than KPI\_ref is increasing linearly. However, the cost functions can also take other shapes.

The total cost function to be optimised, i.e. minimized, is presented in equation (3). A trade-off between capacity and quality requirements can be accomplished using the parameter  $W$ . The minimization is performed by adjusting the configuration parameters (2). The KPI values also depend on the service distribution, e.g. different costs and parameter settings will be achieved depending on the service distribution.

$$\begin{aligned} KPI\_C_i &= f(\text{Configuration parameters}, \text{Service Distribution}) \\ KPI\_Q_j &= f(\text{Configuration parameters}, \text{Service Distribution}) \end{aligned} \quad (2)$$

10

$$\text{Total COST} = W * \text{QualityCost} + (1 - W) * \text{CapacityCost} \quad (3)$$

Factors that may affect the optimisation process are for example the traffic profile (service mix), traffic density, pricing of each service etc. The ultimate goals when minimizing the total cost include to optimise the operators revenue, to minimise CAPEX and OPEX, as well as to maintain good reputation of the operator.

A specific example of the cost function TOTAL COST can be calculated according to equations (4) to (8) as follows:

$$(4) \quad \text{TOTAL COST} = C(\text{Queuing Ratio}) + C(\text{BAD Quality Ratio}) + C(\text{Dropping Ratio}) + C(\text{Blocking Ratio})$$

25 with

$$(5) \quad C(\text{Queuing Ratio}) = 0.05 * \text{Dev}(\text{Queuing Ratio} - \text{allowed Queuing Ratio})$$

$$(6) \quad C(\text{Bad Quality Ratio}) = 0.2 * \text{Dev}(\text{Bad Quality Ratio} - \text{allowed Bad Quality Ratio}) \quad (6)$$

- 13 -

- (7)  $C(\text{Dropping Ratio}) = 1 * \text{Dev}(\text{Dropping Ratio} - \text{allowed Dropping Ratio})$
- (8)  $C(\text{Blocking Ratio}) = 0.10 * \text{Dev}(\text{Blocking Ratio} - \text{allowed Blocking Ratio})$

5

The optimisation challenge is to combine seamlessly all the different TOM management layers, wherein the fact, that the measurements (quality and cost indicators) from different layers use different language, should be taken into account.

10

When the optimising process is implemented in the NMS of a network, the operators' decision on the customer care and service management layers are supported. To be able to do this a derivation of cost functions including configuration and (PM) measurements performed on the lower layer are translated to "language" on the layer above. This can be carried out by:

15

Performing a technical translation (mapping) from Radio Access Network parameter (settings) to service related quality expectations/targets. In practise this means correlating the configuration management and performance management. I.e. certain configured functional entity is monitored by certain set of measurements. The performance of the entity is derived with a cost function utilising the defined measurements.

20

In practise the following means translation of measurements of larger entity (i.e. cell, traffic class, etc.) to user level entity be able to statistically conclude the quality of individual users. Also this step is performed with a weighted cost function(s). Furthermore, it is possible to combine these individual translations with cost function to achieve wanted end user quality indication.

25  
30

- 14 -

- 1) A technical translation (mapping) from Radio Access Network measurements (network performance) to end user flow level grade of service (experienced quality).
- 5    2) A technical translation from aggregate level (UMTS traffic classes) parameters settings to end user flow level grade of service (experienced quality),
- 3) A technical mapping from measurements per traffic class to settings to  
10    end user flow level grade of service (experienced quality),

and/or a combination function of traffic class and flow level information (parameters and settings) with a cost function to support the parameterising and monitoring of end user GOS.

15

Fig. 5 shows an illustration of the combination of network monitoring and optimising functions which are used to combine different management layers within the network by mapping.

- 20    The mapping is carried out from one layer to the next one by combining the network measurements, the performance indicators PI and/or the KPI with a cost function

- And cost function for the grade of service GOS as experienced by the  
25    subscriber can be calculated as described in equation (9):

$$(9) \quad \text{GOS} = C(\text{Service Availability}) + C(\text{Delay and Jittering}) + \\ C(\text{Quality}) + C(\text{Dropping}) + C(\text{Service Accessibility}) + \\ C(\text{Equivalent Bitrate or User throughput})$$

30



- 15 -

Wherein the delay is composed of Service Access Delay and Queuing Transmission Delay. Non real-time quality is influenced by packet loss, Radio Link Control RLC, Packet Data Convergence Protocol PDCP, i.e. by the bit error rate BER and the block error rate BLER. Regarding the real-time quality the quality is bad if uplink UL block error rate BLER is significantly higher than the target BLER. The real-time quality is influenced by the downlink DL connection power outage. The input of the above cost function comprises capacity requests and traffic distribution. The measurements of the total throughput is carried out in kbps/cell/MHz.

10

The spectral efficiency of the cost function equals to the throughput in kbps/cell/MHz when 98 % of the users are satisfied. This means that the service accessibility and the blocking probability is 2%. The equivalent bit-rate is greater than 10 % of the bearer service data rate and 98% of a users are not dropped. The motivation behind this approach is to metrically assess the benefits of the optimisation in terms of GOS.

15

This mapping has to be done for all services which are provided, i.e. services which are controlled with different parameter settings or other attributes.

20

Although, each translation is causing degradation in accuracy, the mapping is statistically correct. Due to the fact that the operation is carried out in statistical level the best location for the mapping functions is NMS. Furthermore, NMS implementation is also able to handle the Radio Network Controller RNC-RNC (or other network element) border areas. In each of these translations the proposed cost function method is applied. In some of the cases the service QoS targets can cause conflict in the parameter settings, therefore a cost function is needed to solve the conflict. This can be carried out by providing different weight coefficients for the different elements in the cost function. This idea will gain importance when different

25

30

- 16 -

customer classes (silver, bronze, gold. etc) are introduced into the network system.

Furthermore, the next major step when changing to the last management layer of TOM model is to perform the evaluation of the network optimisation, service prioritising as well as customer differentiation operation in terms of €, \$ or £. At this stage the billing and charging information from the Invoicing/Collecting subsystem in the customer care layer of the TOM is needed. When utilizing the knowledge of the customer base/profiles and behaviour of those profiles it is possible - on the basis of a cost function - to optimise the business case of the operator to the direction that is the most beneficial. It is worth noting that changing the customer priorities and offered QoS for business reasons will cause change in the customer behaviour and the business management level optimisation is thus iterative.

To guarantee the optimum performance of a cellular network, it is preferable for the operator to have flexible means to set the QoS target based on the system KPIs (key performance indicator) and/or a cost function derived from those. The QoS targets may either be set for a cell cluster or per cell basis. The QoS can be evaluated in terms of blocked calls due to hardware resources, "soft" blocked calls (in interference limited networks), dropped calls, bad quality calls, number of retransmissions and delay in case of packed data, diversity handover probability, hard handover success rate, loading situation (uplink UL or downlink DL), ratio of packed data to circuit switched services etc.

In multi-radio environments (GSM-WCDMA Global System for Mobile Communications - Wideband Code Division Multiple access) it is important to have the possibility to pool the resources of both of the networks for optimised capacity, coverage and quality. This requires an over all control functionality (quality manager) on higher (KPI) level, i.e. the optimising

- 17 -

process according to the invention can be implemented as the quality manager.

5 The quality manager QM, i.e. the optimising process, provides a central monitoring function and monitors the status of the parameter values and identify automatically the problem situation by comparing the history information of the parameter values as stored in the history database. E.g. GERAN and UMTS Terrestrial Radio Access Network UTRAN can be split into auto-tuning subsystems as small and independent as possible. Inter-  
10 dependencies between subsystems are taken into account in upper layers of quality manager, by providing weight coefficients for the KPI's of their respective subsystems.

15 In another embodiment, the optimising process is carried out on the basis of user groups (like business users, free time uses etc.).

Summarising it can be said that, currently for all the parameter values default value are proposed. Up till now was the operator's task to optimise the network cell by cell (trying to take the multi-cell environment into account). However, by using the method and/or the system for optimising the  
20 network performance according to the invention the initial parameter setting could be made less important. For example in the beginning of the network operation the admission control and handover control could work with very "loose" limits admitting all the users to the network, based on the current QoS situation (KPIs at the operating service system OSS) and the  
25 set QoS targets the relevant parameters can be auto-tuned. After the parameter change the new situation, i.e. the new KPI values, is compared to the KPI history data and the "test" parameters are accepted if the change in the QoS performance (or the cost function of the QoS requirements) is  
30 improved. The length of the history data depends on the amount of the traffic in the network (total number of samples should be high enough). It

- 18 -

is important that the QoS cost function contains items from the whole RRM and multi-radio area.

5 The key parameters (in terms of optimum capacity and quality) are currently initially set to a "default" value, which in most cases guarantees operation of the network but not the optimum performance. The optimising process according to the invention automatically changes the settings for the essential parameters to the optimum operating point in terms of overall QoS.

10

The adjustments of the configuration parameters can be constant increments or decrements. Alternatively, the increments or decrements can be made variable.

15

- 19 -

### Claims

1. A method for optimising the performance of a network, in particular a radio network performance, comprising the steps of:
  - 5 - determining relevant key performance indicators for an entity within the network and first parameters, upon which said key performance indicators depend on,
    - selecting a number of similar entities,
    - calculating a first cost function on the basis of the determined key
  - 10 performance indicators and the selected number of entities, in order to evaluate the network performance on the basis of first values of said first parameters, wherein said first values of said first parameters represent the current values of said first parameters,
    - adjusting the values of said first parameters resulting in second
  - 15 values of said first parameters,
    - re-calculating said first cost function on the basis of the key performance indicators as determined according to said second values of said first parameters to evaluate the network performance,
    - comparing the result of said first cost function according to said
  - 20 first values of said first parameters with the result of said first cost function according to said second values of said first parameters to determine whether the network performance has improved,
    - adopt said second values of said first parameters as permanent parameters if the network performance on the basis of said second values
  - 25 of said first parameters has improved.
2. A method according to claim 1,
  - wherein the respective determined key performance indicators are weighted with different weight coefficients within said first cost function.
- 30 3. A method according to claim 1 or 2,

- 20 -

wherein reference values for the key performance indicators are set, and the difference between the current key performance indicators and the respective reference values thereof are determined and are used as elements in said first cost function.

5

4. A method according to any one of the preceding claims,  
wherein said first cost function is composed of a second cost function representing the quality requirements within the network and a third cost function representing the capacity requirements within the network,  
10 wherein said second cost function is weighted with a second weight coefficient and said third cost function is weighted with a third weight coefficient.

5. A method according to claim 4,  
wherein said third weight coefficient equals to said second weight  
15 coefficient subtracted from one.

6. A method according to any one of the preceding claims,  
wherein said second and third cost functions comprise the determined key performance indicators for each selected entity as elements.  
20

7. A method according any one of the preceding claims,  
wherein said entity within the network is represented by a cell or a user group within said network.

25 8. A method according to any of the preceding claims,  
wherein the steps for optimising the network performance are iterated.

9. A method according to any of the preceding claims, comprising the  
30 step of:

- storing the values of the key performance indicators together with

- 21 -

the respective first parameters and the corresponding result of the first cost function in order to create a history database.

10. A method according to any of the preceding claims, wherein the  
5 comparing step includes the steps of:

- comparing the results of said first cost function with stored previous results of the first cost function in said history database in order to determine whether the network performance has improved within the predetermined time interval, and
- 10 - notifying if no improvements of the network performance has been made in said predetermined time interval.

11. A method according to any preceding claims,  
wherein quality of service indications for services and/or individual  
15 subscribers are derived from measurements and/or configurations of low management layers within the network.

12. A system for optimising the performance of a network, in particular a radio network performance, comprising:

- 20 a) means for determining a relevant key performance indicator for an entity within said network and a first parameter, upon which said key performance indicator depends on,
- b) means for selecting at least one similar entity,
- c) means for calculating a first cost function on the basis of said determined key performance indicator and said selected at least one entity,  
25 in order to evaluate the network performance on the basis of a first value of said first parameter, wherein said first value of said first parameter represents a current value of said first parameter,
- d) means for adjusting said first value of said first parameter to obtain  
30 a second value of said first parameter,
- e) means for re-calculating said first cost function on the basis of said

- 22 -

relevant key performance indicator determined according to said second value of said first parameter to evaluate the network performance,

- f) means for comparing the result of said first cost function according to said first value of said first parameter with the result of said first cost function according to said second value of said first parameter to determine whether the network performance has improved, and
- g) means for adopting said second value of said first parameter as permanent parameters if the network performance on the basis of said second value of said first parameters has improved.

10

13. A Computer program product comprising computer program code means for causing a computer to perform the steps of the method as claimed in 1 to 10 when said computer program is run on a computer.

15



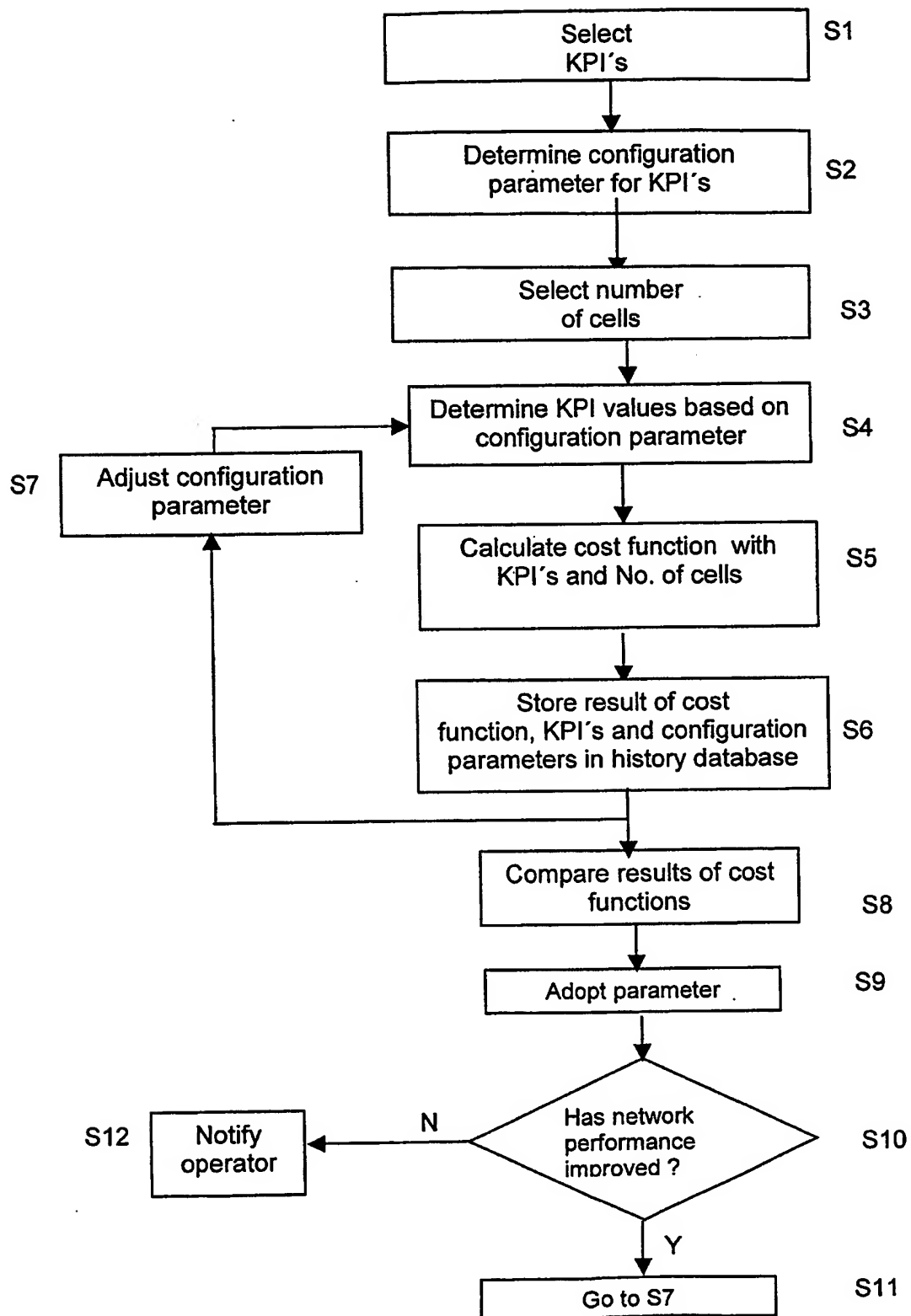


Fig. 1

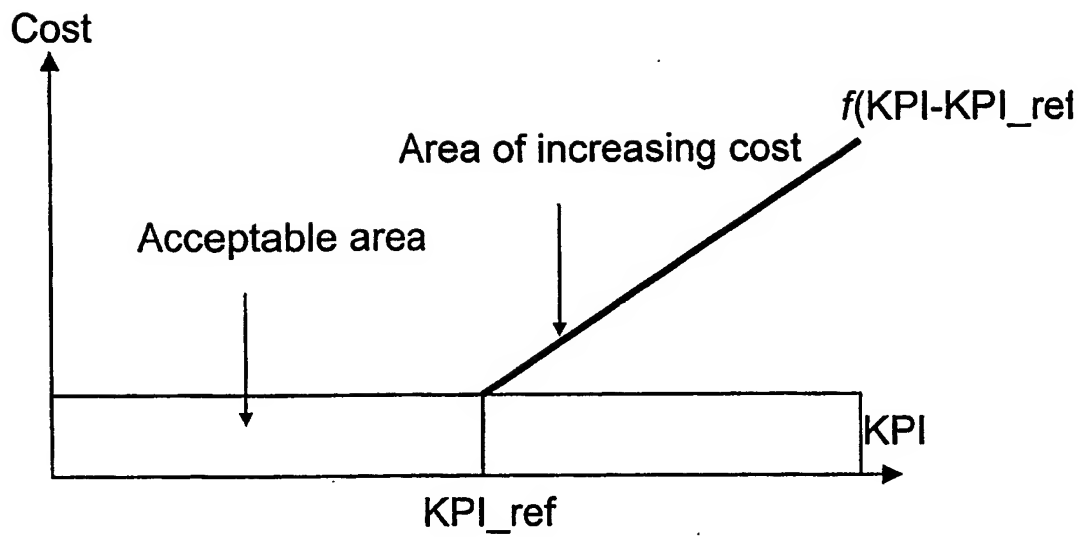


Fig. 2

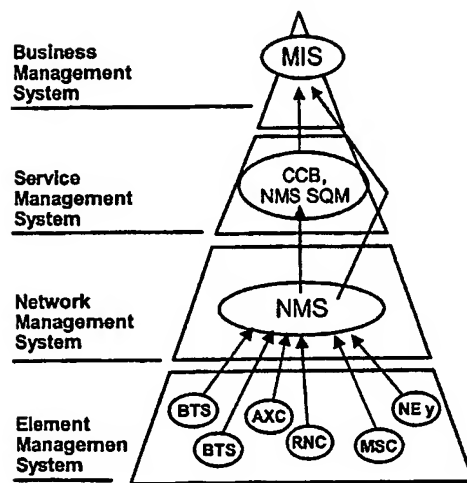


Fig. 3

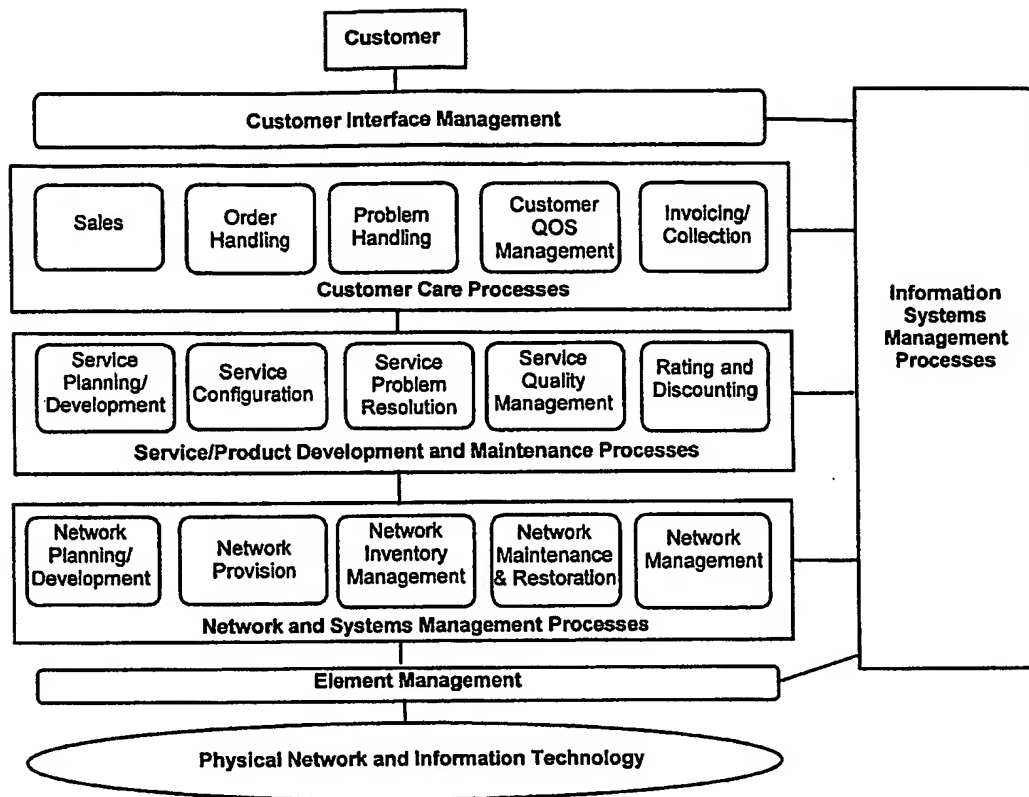


Fig. 4

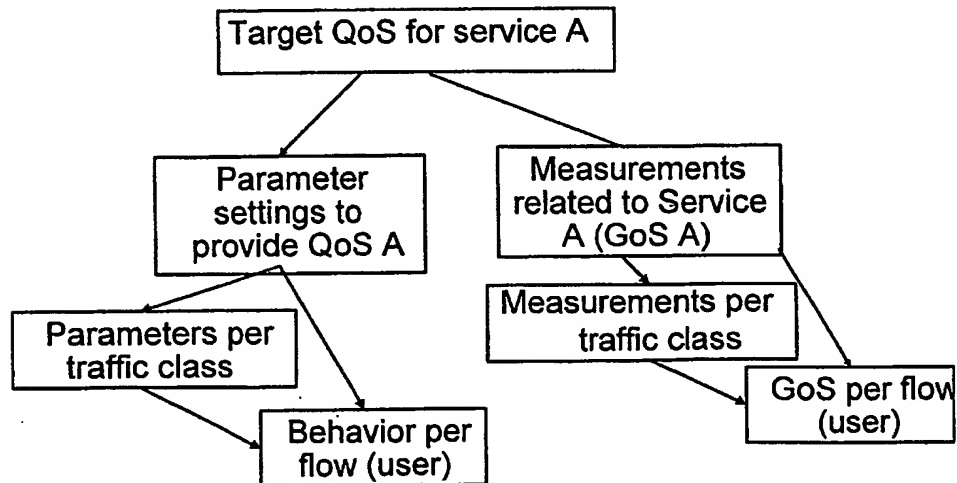


Fig. 5

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 01/12374

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H04Q7/36 H04L12/24

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, IBM-TDB, INSPEC, COMPENDEX

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 5 598 532 A (LIRON MOSHE) 28 January 1997 (1997-01-28) abstract claims 1-7,9,10 figures 2,3 column 1, line 56 -column 2, line 11 column 2, line 37-58 column 3, line 27-43 column 5, line 29-42 column 6, line 23-51 column 7, line 66 -column 8, line 48 --- -/--	1-3,7,8, 12,13 4-6,9-11

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

26 July 2002

Date of mailing of the international search report

02/08/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Cichra, M

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 01/12374

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP 1 098 546 A (LUCENT TECHNOLOGIES INC) 9 May 2001 (2001-05-09) abstract claims 1-3,7-21 page 3, line 27-41 page 4, line 12-24 page 6, line 40 -page 7, line 9 page 9, line 57 -page 10, line 18 page 10, line 43 -page 11, line 8 page 15, line 16-39	1-3,7,8, 12,13 4-6,9-11
A	EP 0 889 656 A (NORTHERN TELECOM LTD) 7 January 1999 (1999-01-07) abstract tables 1,2 claims 1,7 page 2, line 55 -page 3, line 34 page 9, line 24-38 page 10, line 22-47	1-13
A	US 5 809 282 A (COOPER DENNIS ET AL) 15 September 1998 (1998-09-15) abstract figures 3,7 claims 1,5,7-11 column 1, line 5-25 column 9, line 27-48 column 12, line 27 -column 13, line 59	1-13
A	EP 1 098 544 A (LUCENT TECHNOLOGIES INC) 9 May 2001 (2001-05-09) abstract claims 1,9-11,24 page 3, line 10-25 page 4, line 1-18 page 4, line 48 -page 5, line 37 paragraph '02.4!	1-13

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 01/12374

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5598532	A	28-01-1997	NONE	
EP 1098546	A	09-05-2001	AU 6958600 A BR 0006771 A CN 1295417 A EP 1098546 A2 JP 2001204082 A	10-05-2001 14-08-2001 16-05-2001 09-05-2001 27-07-2001
EP 0889656	A	07-01-1999	US 5970064 A CA 2230424 A1 EP 0889656 A2 JP 11017704 A	19-10-1999 12-12-1998 07-01-1999 22-01-1999
US 5809282	A	15-09-1998	AU 6269396 A WO 9641451 A1 US 5934215 A	30-12-1996 19-12-1996 10-08-1999
EP 1098544	A	09-05-2001	AU 6958700 A BR 0006770 A CN 1295416 A EP 1098544 A2 JP 2001203631 A	10-05-2001 14-08-2001 16-05-2001 09-05-2001 27-07-2001